

先进机器人驱动技术 (ME337) 课程大纲

- 1、2019 秋季学期——2020 秋季学期
- 2、2021 秋季学期起

课程详述

COURSE SPECIFICATION

以下课程信息可能根据实际授课需要或在课程检讨之后产生变动。如对课程有任何疑问，请联系授课教师。

The course information as follows may be subject to change, either during the session because of unforeseen circumstances, or following review of the course at the end of the session. Queries about the course should be directed to the course instructor.

1.	课程名称 Course Title	先进机器人驱动技术 Advanced Actuation for Robots
2.	授课院系 Originating Department	机械与能源工程系 Department of Mechanical and Energy Engineering
3.	课程编号 Course Code	ME337
4.	课程学分 Credit Value	3
5.	课程类别 Course Type	专业核心课 Major Core Courses
6.	授课学期 Semester	秋季 Fall (2019 秋季学期——2020 秋季学期)
7.	授课语言 Teaching Language	中英双语 English & Chinese
8.	授课教师、所属学系、联系方式 (如属团队授课, 请列明其他授课教师) Instructor(s), Affiliation & Contact (For team teaching, please list all instructors)	王宏强 WANG Hongqiang

9.	实验员/助教、所属学系、联系方式 Tutor/TA(s), Contact	张一帆 13602530533				
10.	选课人数限额(可不填) Maximum Enrolment (Optional)					
11.	授课方式 Delivery Method	讲授 Lectures	习题/辅导/讨论 Tutorials	实验/实习 Lab/Practical	其它(请具体注明) Other (Please specify)	总学时 Total
	学时数 Credit Hours	32		32		64
12.	先修课程、其它学习要求 Pre-requisites or Other Academic Requirements	MA102B 高等数学 A 下 Calculus II A				
13.	后续课程、其它学习规划 Courses for which this course is a pre-requisite					
14.	其它要求修读本课程的学系 Cross-listing Dept.					

教学大纲及教学日历 SYLLABUS

15. **教学目标 Course Objectives**

本课程主要讲授机器人领域常用驱动器以及科技前沿的新兴驱动方式的基本结构、基本工作原理和工作特性，如电磁电机、软体气动驱动器、液压驱动器、压电电机、静电电机、形状记忆合金、IPMC、介电弹性体等。通过本课程的学习，希望建立学生对机器人驱动技术的基本认知，培养其基本的驱动器设计和分析能力，掌握常见驱动器关键参数的计算方法，使学生在机器人设计过程中科学选用合适的驱动器。培养学生的创新实践能力，从基本物理原理开发新型驱动器的能力，科学成果撰写和表达能力。

This course introduces to students the basic structure, principle and working characteristics of common and cutting-edge actuators in robotics, including electromagnetic motor, soft pneumatic actuator, hydraulic driver, piezoelectric motor, electrostatic actuator, shape memory alloy, ion-exchange polymer metal composite (IPMC) and dielectric elastomer, etc. This course committed to educating students with knowledge of the driving technologies mentioned above, to design and analyse basic actuators, to further master the calculation methods of the key parameters of common actuators, and finally, to select the appropriate actuators in the process of robot design. This course also aims to foster the capability of

innovation and academic writing and presentation, by develop new actuators from the basic principles.

16. 预达学习成果 Learning Outcomes

学习本课程后，应达到如下学习成果：

1. 了解各类驱动器的基本结构；
2. 理解各类驱动器的基本工作原理和工作特性；
3. 掌握各类电磁电机正常运行时的基本方程式；
4. 掌握各类驱动器的分析计算方法；
5. 具备独立完成驱动器选型的能力。
6. 科研表达能力
7. 科研创新能力

Students are expected to achieve the following goals after finishing this course:

1. Understand the basic structure of different types of actuators introduced;
2. Comprehend the basic principle and working characteristics of different types of actuators;
3. Master the basic equations of different types of electromagnetic motors in the working conditions;
4. Master the analytical calculation methods of different types of actuators;
5. Be capable of selecting the appropriate actuators independently.
6. Academic writing and presentation capability
7. Innovation capability

17. 课程内容及教学日历（如授课语言以英文为主，则课程内容介绍可以用英文；如团队教学或模块教学，教学日历须注明主讲人）

Course Contents (in Parts/Chapters/Sections/Weeks. Please notify name of instructor for course section(s), if this is a team teaching or module course.)

课程内容	教学要求	学时分配
<p>绪论</p> <ul style="list-style-type: none"> • 各类驱动器的发展历程 • 各类驱动器的应用场景 • 本课程的性质、任务和主要内容 • Development of different types of actuators • Application scenario of different types of actuators • Syllabus, including course type, assignment and main contents of the course 	<p>了解各类型驱动器的历史背景、应用场景，了解本课程的学习目标与主要内容</p> <p>Understand the historical background and application scenarios of different types of actuators, and the learning objectives and main contents of this course</p>	2
<ul style="list-style-type: none"> • 静电电机的基本工作原理 • 静电电机的关键设计参数 • 静电电机的制造方法 • 静电电机的应用场景 • Principles of electrostatic actuators • Key design parameters of electrostatic actuators • Fabrication of electrostatic actuators • Application scenario of electrostatic actuators 	<p>了解静电电机的基本工作原理及关键设计参数，熟悉静电电机的制造方法及应用场景</p> <p>Understand the basic principles of electrostatic actuators and its key design parameters, familiar with the fabrication and application of electrostatic actuators</p>	4
<ul style="list-style-type: none"> • 形状记忆合金的分类 • 形状记忆合金的材料及工作原理 • 形状记忆聚合物的材料及工作原理 • 形状记忆合金、形状记忆聚合物的应用场景 • Classification of shape memory alloys (SMA) • Principles and materials of shape memory alloys • Principles and materials of shape memory polymers (SMP) • Application scenario of SMA and SMP 	<p>了解形状记忆合金的分类、形状记忆合金的材料、形状记忆聚合物的材料，熟悉形状记忆合金、形状记忆聚合物的工作原理及应用场景</p> <p>Understand the classification and materials of SMA and SMP, familiar with the principles and application scenario of SMA and SMP</p>	2
<ul style="list-style-type: none"> • 液压、气压驱动的基本原理 • 液体、气体动力学的基本概念 • 液体、气体软体驱动的方式和方法 • 液压、气压驱动的常用元件 • 液压、气压泵的工作原理 	<p>了解液压、气压驱动的基本原理及适用场景，熟悉液压、气压泵的工作原理，掌握液体、气体动力学的基本概念、掌握液压、气压驱动的常用元件选用方法</p> <p>Understand the basic principles and applications of hydraulic and pneumatic driving, familiar with the principles of hydraulic pump and air pump, master the basic concepts of hydrodynamics and gas kinetics,</p>	4

<ul style="list-style-type: none"> • 液压、气压驱动的适用场景 • Basic principles of hydraulic and pneumatic actuators • Basic concepts of hydrodynamics and gas kinetics • Common components for hydraulic and pneumatic driving • Principles of hydraulic pump and air pump • Applications of hydraulic and pneumatic driving 	<p>and selection methods for common components of hydraulic and pneumatic driving</p>	
<ul style="list-style-type: none"> • 压电效应 • 常见压电材料 • 压电驱动器的关键参数 • 压电驱动器的应用场景 • Piezoelectric effect • Common piezoelectric materials • Key design parameters of piezoelectric actuators • Application scenario of piezoelectric actuators 	<p>了解常见压电材料的种类、压电驱动器的关键参数，熟悉压电效应的内容及压电驱动器的应用场景 Learn about the common piezoelectric materials, the key design parameters of piezoelectric actuators, familiar with the piezoelectric effect and application scenario of piezoelectric actuators</p>	2
<ul style="list-style-type: none"> • 离子交换聚合金属材料驱动器的工作原理 • 离子交换聚合金属材料驱动器的应用场景 • 离子交换聚合金属材料驱动器的制造方法 • 介电弹性体驱动器的工作原理 • 介电弹性体驱动器的应用场景 • 介电弹性体驱动器的制造方法 • Principles of ion-exchange polymer metal composite (IPMC) • Application scenario of IPMC • Fabrication of IPMC • Principle of dielectric elastomer actuators (DEA) • Application scenario of DEA • Fabrication of DEA 	<p>了解离子交换聚合金属材料驱动器的制造方法，熟悉离子交换聚合金属材料驱动器的工作原理和应用场景 了解介电弹性体驱动器的制造方法，熟悉介电弹性体驱动器的工作原理和应用场景 Understand the fabrication of IPMC, familiar with the principles and application of IPMC Understand the fabrication of DEA, familiar with the principles and application scenario of DEA</p>	2
<ul style="list-style-type: none"> • 磁路概述 • 磁链、电感和能量 	<p>了解磁路的基本概念，熟悉磁性材料的特性和永磁材料的应用，掌握磁链、电感和能量的计算方法 Understand the basic concepts of magnetic circuits, familiar with the</p>	2

<ul style="list-style-type: none"> • 磁性材料的特性 • 永磁材料的应用 • Introduction to magnetic circuits • Flux linkage, inductance, and energy • Properties of magnetic materials • Application of permanent magnet materials 	<p>properties of magnetic materials and application of permanent magnet materials, master the calculation methods of flux linkage, inductance, and energy</p>	
<ul style="list-style-type: none"> • 变压器概述 • 二次侧电流的影响和理想变压器 • 变压器电抗及等效电路 • 变压器的工程分析 • 自耦变压器和多绕组变压器 • 三相变压器 • 电压互感器和电流互感器 • Introduction to transformers • Effect of secondary current and ideal transformer • Transformer reactance and equivalent circuits • Engineering aspects of transformer analysis • Autotransformers and multiwinding transformers • Transformers in three-phase circuits • Voltage and current transformers 	<p>了解变压器的工程分析、自耦变压器和多绕组变压器，熟悉变压器的基本概念、二次侧电流的影响和理想变压器、变压器电抗及等效电路、三相变压器、电压互感器和电流互感器</p> <p>Understand engineering aspects of transformer analysis, and autotransformers and multiwinding transformers, familiar with the basic concepts of transformers, effect of secondary current and ideal transformer, transformer reactance and equivalent circuits, transformers in three-phase circuits, and voltage and current transformers</p>	4
<ul style="list-style-type: none"> • 磁场系统中的力和力矩 • 能量法 • 单边励磁磁场系统中的能量 • 由储能确定磁场力和转矩 • 由磁共能确定电磁力和转矩 • Forces and torques in magnetic field systems • Energy balance • Energy in singly-excited magnetic field systems • Determination of magnetic force and torque from energy 	<p>熟悉由储能确定磁场力和转矩、由磁共能确定电磁力和转矩的方法，掌握电磁系统中的力和力矩、能量法、单边励磁磁场系统中的能量</p> <p>Familiar with determination of magnetic force and torque from energy, and determination of magnetic force and torque from coenergy, master forces and torques in magnetic field systems, energy balance, and energy in singly-excited magnetic field systems</p>	4

<ul style="list-style-type: none"> • Determination of magnetic force and torque from coenergy 		
<ul style="list-style-type: none"> • 交流和直流电机概述 • 分布绕组的磁势 • 旋转电机中的磁场 • 交流电机中的旋转磁势波 • 感应电势 • 隐极电机的转矩 • 直线电机 • Introduction to AC and DC motors • MMF of distributed windings • Magnetic fields in rotating motorry • Rotating MMF waves in AC motors • Generated voltage • Torque in Nonsalient-Pole motors • Linear motors 	<p>了解直线电机的基本概念，熟悉交流和直流电机的类型及特性、分布绕组的磁势、交流电机中的旋转磁势波，掌握旋转电机中的磁场、感应电势、隐极电机的转矩</p> <p>Understand the basic concepts of linear motors, familiar with the types and properties of AC and DC motors, and MMF of distributed windings, rotating MMF waves in AC motors, master magnetic fields in rotating motorry, generated voltage, and torque in Nonsalient-Pole motors</p>	4
<ul style="list-style-type: none"> • 课程汇报 • Reports 	课程作业汇报	2
实验 (Experiment) :		
<ul style="list-style-type: none"> • 静电电机驱动实验 • Experiments on electrostatic actuators 	学习静电电机驱动系统的搭建 Learn the skill to build an electrostatic actuation system,	2
<ul style="list-style-type: none"> • 软体气动驱动器实验 • Experiments on electrostatic actuators 	学习软体气动机器人系统的搭建 Learn the skill to build an electrostatic actuation system,	2
<ul style="list-style-type: none"> • 形状记忆合金驱动器实验 • Experiments on shape memory alloy actuators 	学习形状记忆合金驱动器系统的搭建 Learn the skill to build an electrostatic actuation system,	2
<ul style="list-style-type: none"> • 小组创新项目选题 • Team innovation project • 	讨论创新设计或应用新型驱动技术 选题方向 Learn to develop or apply novel actuation techniques	4
<ul style="list-style-type: none"> • 小组创新项目概念设计 	进行创新设计或应用新型驱动技术 选题的概念性设计	4

<ul style="list-style-type: none"> • Team innovation project conceptual design • 	Learn to conceptual design machines using novel actuation techniques	
<ul style="list-style-type: none"> • 小组创新项目原理样机加工制作 • Team innovation project prototype fabrication • 	创新设计或应用新型驱动技术方案样机加工 prototype fabrication to develop or apply novel actuation techniques	4
<ul style="list-style-type: none"> • 小组创新项目原理验证 • Team innovation project proof of concept • 	验证创新设计或应用新型驱动技术选题方案 Learn to prove the prototype using novel actuation techniques	4
<ul style="list-style-type: none"> • 小组创新项目测试 • Team innovation project measurement and evaluation • 	创新设计或应用新型驱动技术样机进行测试 Test the prototype by developing or applying novel actuation techniques	4
<ul style="list-style-type: none"> • 小组创新项目最终机器人系统集成和应用示范 • Team innovation project final assembly • 	对创新设计或应用新型驱动技术的原型样机进行机器人系统集成和应用领域示范 Learn to integrate the novel actuation techniques into robots and demonstrate the applications	4
<ul style="list-style-type: none"> • 最终汇报 • Final Presentation 	创新设计汇报 Final presentation for innovation projects	2

18. 教材及其它参考资料 Textbook and Supplementary Readings

《电机学（第七版）》 电子工业出版社 Stephen D. Umans 著, 刘新正、苏少平、高琳译
《电机学》 西安交通大学出版社 阎治安, 苏少平, 崔新艺著

课程评估 ASSESSMENT

19. 评估形式	评估时间	占考试总成绩百分比	违纪处罚	备注
Type of Assessment	Time	% of final score	Penalty	Notes
出勤 Attendance		10	每缺席一次扣除2%, 缺席三次以上扣除全部10%	
课堂表现 Class Performance				
小测验				

Quiz				
课程项目 Projects		40		
平时作业 Assignments		30		
期中考试 Mid-Term Test				
期末考试 Final Exam				
期末报告 Final Presentation		20		
其它（可根据需要 改写以上评估方式） Others (The above may be modified as necessary)				

20. 记分方式 GRADING SYSTEM

- A. 十三级等级制 Letter Grading
 B. 二级记分制（通过/不通过） Pass/Fail Grading

课程审批 REVIEW AND APPROVAL

21. 本课程设置已经过以下责任人/委员会审议通过

This Course has been approved by the following person or committee of authority

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课程详述

COURSE SPECIFICATION

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The course information as follows may be subject to change, either during the session because of unforeseen circumstances, or following review of the course at the end of the session. Queries about the course should be directed to the course instructor.

1.	课程名称 Course Title	先进机器人驱动技术 Advanced actuation for robots
2.	授课院系 Originating Department	机械与能源工程系 Department of Mechanical and Energy Engineering
3.	课程编号 Course Code	ME337
4.	课程学分 Credit Value	3
5.	课程类别 Course Type	专业核心课 Major Core Courses
6.	授课学期 Semester	秋季 Fall (2021 秋季学期起)
7.	授课语言 Teaching Language	英语 English
8.	授课教师、所属学系、联系方式 (如属团队授课, 请列明其他授课教师) Instructor(s), Affiliation & Contact (For team teaching, please list all instructors)	王宏强 WANG Hongqiang 潘阳 PAN Yang

9.	实验员/助教、所属学系、联系方式 Tutor/TA(s), Contact	无 NA / 待公布 To be announced / 已确定的实验员/助教联系方式 Please list all Tutor/TA(s) 待公布 To be announced (请保留相应选项 Please only keep the relevant information)				
10.	Maximum Enrolment (Optional)					
11.	授课方式 Delivery Method	讲授 Lectures	习题/辅导/讨论 Tutorials	实验/实习 Lab/Practical	其它(请具体注明) Other (Please specify)	总学时 Total
	学时数 Credit Hours	32		32		64
12.	先修课程、其它学习要求 Pre-requisites or Other Academic Requirements	高等数学 A 下				
13.	后续课程、其它学习规划 Courses for which this course is a pre-requisite	无				
14.	其它要求修读本课程的学系 Cross-listing Dept.	无				

教学大纲及教学日历 SYLLABUS

15. **教学目标 Course Objectives**

本课程主要从系统的角度讲授机器人驱动器的基本结构、基本工作原理和工作特性，如电磁电机、软体气动驱动器、液压驱动器、压电电机、静电电机、形状记忆合金、IPMC、介电弹性体等，同时兼顾电机的传感技术、控制技术等。通过本课程的学习，希望建立学生对机器人驱动系统的基本认知，培养其基本的驱动器设计和分析能力，掌握常见驱动器关键参数的计算方法，使学生在机器人设计过程中科学选用合适的驱动电路及其相应的传感和控制方法。培养学生的创新实践能力，从基本物理原理开发新型驱动器的能力，科学成果撰写和表达能力。

This course introduces to students the basic structure, principle and working characteristics of common and cutting-edge actuators in robotics, from system perspective, including electromagnetic motor, soft pneumatic actuator, hydraulic driver, piezoelectric motor, electrostatic actuator, shape memory alloy, ion-exchange polymer metal composite (IPMC) and dielectric elastomer, etc, and the regular sensors and control methods. This course committed to educating students with knowledge of the driving technologies mentioned above, to design and analyse basic actuators and their actuators and control methods, to further master the calculation methods of the key parameters of common actuators, and finally, to select the appropriate actuators in the process of robot design. This course also aims to foster the capability of innovation

and academic writing and presentation, by develop new actuators from the basic principles.

16. 预达学习成果 Learning Outcomes

学习本课程后，应达到如下学习成果：

1. 了解各类驱动器的基本结构；
2. 理解各类驱动器的基本工作原理和工作特性；
3. 掌握各类电磁电机正常运行时的基本方程式；
4. 掌握各类驱动器的分析计算方法；
5. 具备独立完成驱动器选型的能力。
6. 理解各类驱动器系统中传感与控制的原理与方法。
7. 科研表达能力
8. 科研创新能力

Students are expected to achieve the following goals after finishing this course:

1. Understand the basic structure of different types of actuators introduced;
2. Comprehend the basic principle and working characteristics of different types of actuators;
3. Master the basic equations of different types of electromagnetic motors in the working conditions;
4. Master the analytical calculation methods of different types of actuators;
5. Be capable of selecting the appropriate actuators independently.
6. Understand the method and principle of sensing and controlling for actuation system.
7. Academic writing and presentation capability
8. Innovation capability

- 17. 课程内容及教学日历**（如授课语言以英文为主，则课程内容介绍可以用英文；如团队教学或模块教学，教学日历须注明主讲人）

Course Contents (in Parts/Chapters/Sections/Weeks. Please notify name of instructor for course section(s), if this is a team teaching or module course.)

课程内容	教学要求	学时分配
<p>绪论</p> <ul style="list-style-type: none"> • 机器人系统 • 机器人定义 • 机器人与驱动系统的组成 • 各类驱动器系统的发展历程 • 各类驱动器系统的应用场景 • 本课程的性质、任务和主要内容 • The system of robot • Definition of robot • The components of robots and the actuation system • Development of different types of actuators • Application scenario of different types of actuators • Syllabus, including course type, assignment and main contents of the course 	<p>了解机器人的发展史、组成结构以及各类型驱动器的历史背景、应用场景,了解本课程的学习目标与主要内容</p> <p>Understand the historical background and application scenarios of different types of actuators, and the learning objectives and main contents of this course</p>	2
<ul style="list-style-type: none"> • 磁路概述 • 磁链、电感和能量 • 磁性材料的特性 • 永磁材料的应用 • Introduction to magnetic circuits • Flux linkage, inductance, and energy • Properties of magnetic materials <p>Application of permanent magnet materials</p>	<p>了解磁路的基本概念,熟悉磁性材料的特性和永磁材料的应用,掌握磁链、电感和能量的计算方法</p> <p>Understand the basic concepts of magnetic circuits, familiar with the properties of magnetic materials and application of permanent magnet materials, master the calculation methods of flux linkage, inductance, and energy</p>	4
<ul style="list-style-type: none"> • 变压器概述 • 二次侧电流的影响和理想变压器 • 变压器电抗及等效电路 • 变压器的工程分析 • 自耦变压器和多绕组变压器 • 三相变压器 	<p>了解变压器的工程分析、自耦变压器和多绕组变压器,熟悉变压器的基本概念、二次侧电流的影响和理想变压器、变压器电抗及等效电路、三相变压器、电压互感器和电流互感器</p> <p>Understand engineering aspects of transformer analysis, and autotransformers and multiwinding transformers, familiar with the basic concepts of transformers, effect of secondary current and ideal transformer, transformer reactance and equivalent</p>	4

<ul style="list-style-type: none"> • 电压互感器和电流互感器 • Introduction to transformers • Effect of secondary current and ideal transformer • Transformer reactance and equivalent circuits • Engineering aspects of transformer analysis • Autotransformers and multiwinding transformers • Transformers in three-phase circuits 	<p>circuits, transformers in three-phase circuits, and voltage and current transformers</p>	
Voltage and current transformers		
<ul style="list-style-type: none"> • 磁场系统中的力和力矩 • 能量法 • 单边励磁磁场系统中的能量 • 由储能确定磁场力和转矩 • 由磁共能确定电磁力和转矩 • Forces and torques in magnetic field systems • Energy balance • Energy in singly-excited magnetic field systems • Determination of magnetic force and torque from energy 	<p>熟悉由储能确定磁场力和转矩、由磁共能确定电磁力和转矩的方法，掌握电磁系统中的力和力矩、能量法、单边励磁磁场系统中的能量</p> <p>Familiar with determination of magnetic force and torque from energy, and determination of magnetic force and torque from coenergy, master forces and torques in magnetic field systems, energy balance, and energy in singly-excited magnetic field systems</p>	4
Determination of magnetic force and torque from coenergy		
<ul style="list-style-type: none"> • 电磁电机常见的控制方法 • 电磁电机控制模型 • Control methods for motors • Control modelling for motors 	<p>了解常用的电磁电机的建模与控制方法</p> <p>Familiar with the modelling methods and control methods for the motors</p>	4
<ul style="list-style-type: none"> • 综述机器人的传感器分类 • 主要传感原理与方法 • Review of the categories of robotics sensing • Principle and mechanism of primary sensing methods The key parameters of sensors 	<p>了解机器人综述机器人的传感器分类、理解主要传感原理与方法、传感器的关键参数</p> <p>Understand the categories of the robotics sensing, the principle and mechanism of primary sensing methods</p>	2
<ul style="list-style-type: none"> • 传感器的静态特性 • 传感器的动态特性 	<p>了解机器人传感的关键参数与信号处理方法</p> <p>Understand the Static characteristics of the sensors and dynamic characteristics of the</p>	2

<ul style="list-style-type: none"> • Static characteristics of the sensors • dynamic characteristics of the sensors 	sensors	
<ul style="list-style-type: none"> • 液压、气压驱动的基本原理 • 液体、气体动力学的基本概念 • 液体、气体软体驱动的方式和方法 • 液压、气压驱动的常用元件 • 液压、气压泵的工作原理 • 液压、气压驱动的适用场景 • Basic principles of hydraulic and pneumatic actuators • Basic concepts of hydrodynamics and gas kinetics • Common components for hydraulic and pneumatic driving • Principles of hydraulic pump and air pump • Applications of hydraulic and pneumatic driving 	<p>了解液压、气压驱动的基本原理及适用场景，熟悉液压、气压泵的工作原理，掌握液体、气体动力学的基本概念、掌握液压、气压驱动的常用元件选用方法</p> <p>Understand the basic principles and applications of hydraulic and pneumatic driving, familiar with the principles of hydraulic pump and air pump, master the basic concepts of hydrodynamics and gas kinetics, and selection methods for common components of hydraulic and pneumatic driving</p>	2
<ul style="list-style-type: none"> • 静电电机的基本工作原理 • 静电电机的关键设计参数 • 静电电机的制造方法 • 静电电机的应用场景 • Principles of electrostatic actuators • Key design parameters of electrostatic actuators • Fabrication of electrostatic actuators • Application scenario of electrostatic actuators 	<p>了解静电电机的基本工作原理及关键设计参数，熟悉静电电机的制造方法及应用场景</p> <p>Understand the basic principles of electrostatic actuators and its key design parameters, familiar with the fabrication and application of electrostatic actuators</p>	2
<ul style="list-style-type: none"> • 形状记忆合金的分类 • 形状记忆合金的材料及工作原理 • 形状记忆聚合物的材料及工作原理 • 形状记忆合金、形状记忆聚合物的应用场景 • Classification of shape memory alloys (SMA) • Principles and materials of shape memory alloys • Principles and materials of shape memory polymers (SMP) 	<p>了解形状记忆合金的分类、形状记忆合金的材料、形状记忆聚合物的材料，熟悉形状记忆合金、形状记忆聚合物的工作原理及应用场景</p> <p>Understand the classification and materials of SMA and SMP, familiar with the principles and application scenario of SMA and SMP</p>	2

<ul style="list-style-type: none"> • Application scenario of SMA and SMP 		
<ul style="list-style-type: none"> • 压电效应 • 常见压电材料 • 压电驱动器的关键参数 • 压电驱动器的应用场景 • Piezoelectric effect • Common piezoelectric materials • Key design parameters of piezoelectric actuators • Application scenario of piezoelectric actuators 	<p>了解常见压电材料的种类、压电驱动器的关键参数，熟悉压电效应的内容及压电驱动器的应用场景</p> <p>Learn about the common piezoelectric materials, the key design parameters of piezoelectric actuators, familiar with the piezoelectric effect and application scenario of piezoelectric actuators</p>	2
<ul style="list-style-type: none"> • 离子交换聚合金属材料驱动器的工作原理 • 离子交换聚合金属材料驱动器的应用场景 • 离子交换聚合金属材料驱动器的制造方法 • 介电弹性体驱动器的工作原理 • 介电弹性体驱动器的应用场景 • 介电弹性体驱动器的制造方法 • Principles of ion-exchange polymer metal composite (IPMC) • Application scenario of IPMC • Fabrication of IPMC • Principle of dielectric elastomer actuators (DEA) • Application scenario of DEA • Fabrication of DEA 	<p>了解离子交换聚合金属材料驱动器的制造方法，熟悉离子交换聚合金属材料驱动器的工作原理和应用场景</p> <p>了解介电弹性体驱动器的制造方法，熟悉介电弹性体驱动器的工作原理和应用场景</p> <p>Understand the fabrication of IPMC, familiar with the principles and application of IPMC</p> <p>Understand the fabrication of DEA, familiar with the principles and application scenario of DEA</p>	2
<ul style="list-style-type: none"> • 课程汇报 • Reports 	<p>课程作业汇报</p> <p>Report the progress of the projects</p>	2
<ul style="list-style-type: none"> • 机器人实验室驱动器考察 • Explore the motors have been used in the labs 	<p>了解机器人中电机应用的种类和特性</p> <p>Learn the categories and specifications of motor in different applications</p>	2
<ul style="list-style-type: none"> • 步进电机控制实验 • Experiments on stepper motors 	<p>熟悉步进电机的原理和结构，掌握步进电机的控制方法</p> <p>Learn the principle and structure of stepper motors, and master the controlling methods of stepper motors</p>	4

<ul style="list-style-type: none"> 舵机控制实验 Experiments on digital server motors 	熟悉步进电机的原理和结构，掌握步进电机的控制方法 Learn the principle and structure of stepper motors, and master the controlling methods of stepper motors	4
<ul style="list-style-type: none"> 电机控制实验 Experiments on controlling 	熟悉电机控制方法和通讯方法 Learn the controlling methods and communication methods	4
<ul style="list-style-type: none"> 软体气动驱动器实验 Experiments on electrostatic actuators 	学习软体气动机器人系统的搭建 Learn the skill to build an electrostatic actuation system,	2
<ul style="list-style-type: none"> 形状记忆合金驱动器实验 Experiments on shape memory alloy actuators IPMC 	学习形状记忆合金驱动器系统的搭建 Learn the skill to build an electrostatic actuation system,	2
<ul style="list-style-type: none"> 静电电机驱动实验 Experiments on electrostatic actuators 	学习静电电机驱动系统的搭建 Learn the skill to build an electrostatic actuation system,	2
<ul style="list-style-type: none"> Robotic system integrating actuators 	Learn to build robotic system by combining and controlling multiple actuators	8
<ul style="list-style-type: none"> 最终汇报 Final Presentation 	创新设计汇报 Final presentation for innovation projects	2

18. 教材及其它参考资料 Textbook and Supplementary Readings

池海红, 单蔓红, 王显峰. 自动控制元件 (第二版), 清华大学出版社, 2015.2

《电机学》 西安交通大学出版社 阎治安, 苏少平, 崔新艺著

课程评估 ASSESSMENT

19. 评估形式	评估时间	占考试总成绩百分比	违纪处罚	备注
Type of Assessment	Time	% of final score	Penalty	Notes
出勤 Attendance		10	每缺席一次扣除 2%，缺席三次以上扣除全部 10%	
课程项目 Projects		55		
平时作业 Assignments		35		

期末报告
Final
Presentation

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20. 记分方式 **GRADING SYSTEM**

<input checked="" type="checkbox"/> A. 十三级等级制 Letter Grading <input type="checkbox"/> B. 二级记分制 (通过/不通过) Pass/Fail Grading
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课程审批 **REVIEW AND APPROVAL**

21. 本课程设置已经过以下责任人/委员会审议通过

This Course has been approved by the following person or committee of authority

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